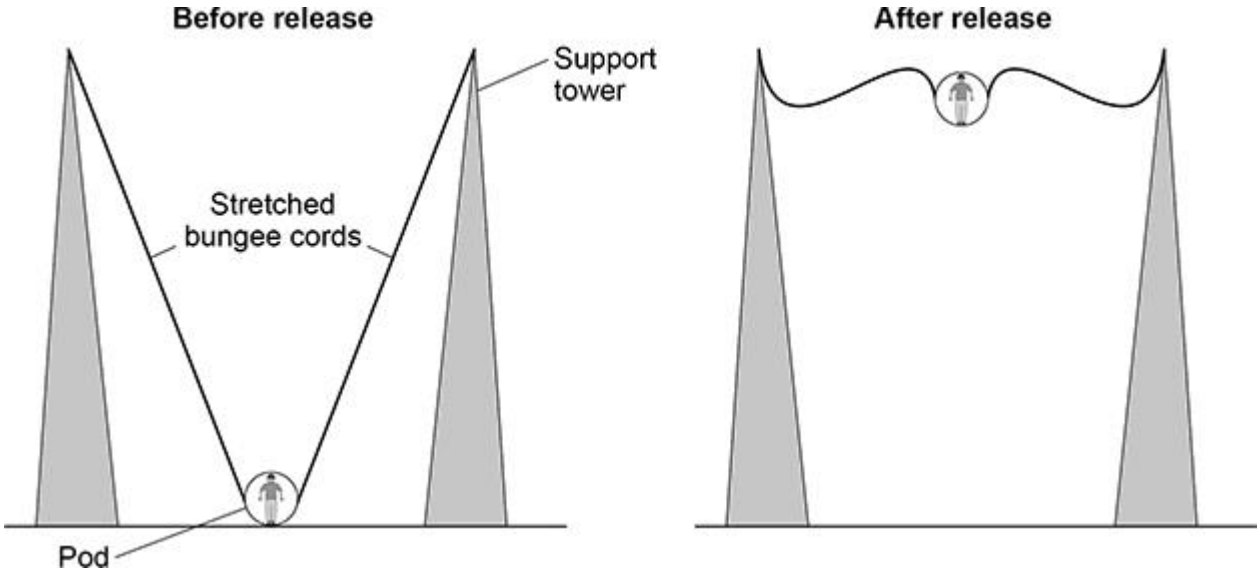
Questions are for both separate science and combined science students

Q1.

In a ride at a theme park, a person is strapped into a pod that is attached to two stretched bungee cords.

The bungee cords behave like springs.

The figure below shows a person using the ride.



(a) How is the extension of each bungee cord calculated?

Tick (✓) **one** box.

stretched length + original length ☐

stretched length – original length ☐

stretched length × original length ☐

stretched length ÷ original length ☐

(1)

(b) Before the pod is released, the extension of each bungee cord is 7.5 m.

spring constant of the bungee cord = 800 N/m

Calculate the elastic potential energy stored in each stretched bungee cord.

Use the equation:

elastic potential energy = 0.5 × spring constant × (extension)^2

_____

_____

_____

Elastic potential energy = _____ J

(2)

(c) The maximum speed of the pod is 15 m/s.

The mass of the pod is 240 kg.

Calculate the maximum kinetic energy of the pod.

Use the equation:

kinetic energy = 0.5 × mass × (speed)^2

_____

_____

_____

Maximum kinetic energy = _____ J

(2)

Use the Physics Equations Sheet to answer parts (d) and (e).

(d) Which equation links gravitational field strength (g), gravitational potential energy (E_p), height (h) and mass (m)?

Tick (✓) **one** box.

$E_p = \frac{m \times g}{h}$ ☐

$E_p = \frac{m}{g \times h}$ ☐

$Ep = m \times g \times h$ ☐

(1)

(e) The pod has 24 000 J of gravitational potential energy when at its maximum height.

The mass of the pod is 240 kg.

gravitational field strength = 9.8 N/kg

Calculate the maximum height reached by the pod.

_____

_____

_____

_____

_____

Maximum height = _____ m

(3)

(f) Why is the maximum gravitational potential energy of the pod less than the initial elastic potential energy of the bungee cords?

Tick (✓) **two** boxes.

- Energy is created. ☐
- Energy is destroyed. ☐
- Energy is transferred to the surroundings. ☐
- Work is done against air resistance. ☐
- Work is done by the force of gravity. ☐
- Work is done by the person in the pod. ☐

(2)

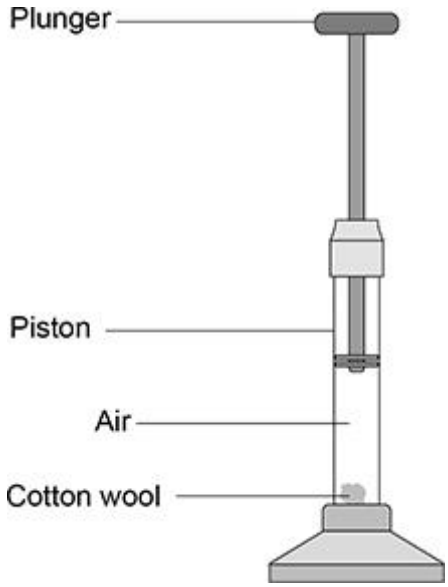
(Total 11 marks)

Q2.

A fire piston is a special type of syringe that can be used to start fires.

Figure 2 shows a fire piston.

Figure 2



The plunger is pushed quickly downwards and compresses the air.

When the air is compressed quickly, the temperature of the air increases.

(a) How does an increase in temperature affect the mean speed of the air particles inside the syringe?

Tick (✓) **one** box.

The mean speed of the particles decreases. ☐

The mean speed of the particles does not change. ☐

The mean speed of the particles increases. ☐

(1)

(b) When the air is hot enough, a small piece of cotton wool in the piston catches fire.

The energy transferred to the air in the piston is 0.0130 J.

The mass of air in the piston is 2.60×10^{-8} kg.

specific heat capacity of air = 1010 J/kg °C

Calculate the temperature change of the air.

Use the Physics Equations Sheet.

Temperature change = _____ °C

(3)

(Total 4 marks)

Q3.

The figure below shows a wind turbine.

Wind turbines may generate electricity when the electricity is not needed.

Two methods that can be used to store the energy from the turbine are:

Method A: Heating water to a high temperature.

Method B: Pumping water uphill into a reservoir.

(a) Which energy store increases when water is heated?

_____

(1)

(b) Which energy store increases when water is pumped uphill into a reservoir?

_____

(1)

(c) The table below shows information about the two methods of storing energy.

Method	Energy stored per 100 kg of water in kJ	Percentage of stored energy wasted	Installation
A: Increasing water temperature by 80 °C	33 600	40%	Anywhere
B: Pumping water uphill to a height of 500 m	490	25%	High mountains

Compare the advantages and disadvantages of the two methods of storing energy.

Include calculations in your answer.

(4)

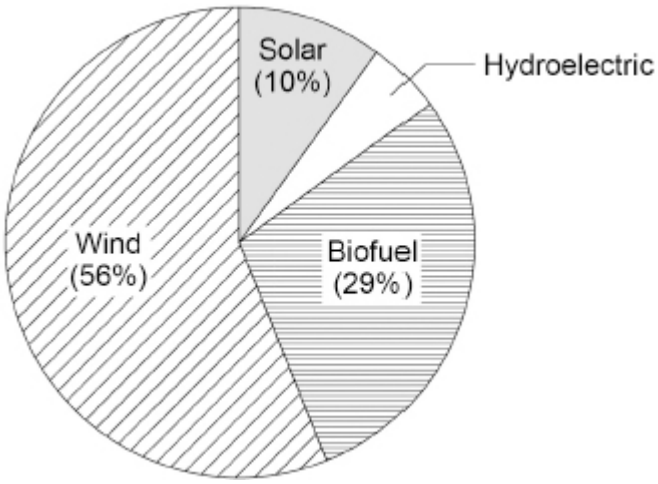
(Total 6 marks)

Q4.

The UK uses renewable energy resources to generate some of its electricity.

Figure 1 shows the proportion of electricity generated by different renewable energy resources in the UK in 2020.

Figure 1



(a) Calculate the percentage of electricity generated using hydroelectric power.

_____

_____

_____

Percentage = _____ %

(2)

A remote village in the UK uses a hydroelectric generator to provide electricity.

(b) The mass of water that passes through the hydroelectric generator each day is 2 500 000 kg.

The change in vertical height of the water is 15.0 m.

gravitational field strength = 9.8 N/kg

Calculate the decrease in gravitational potential energy of the water.

Use the equation:

gravitational potential energy = mass × gravitational field strength × height

_____

_____

Decrease in gravitational potential energy = _____ J

(2)

Use the Physics Equations Sheet to answer parts (c) and (d).

(c) Write down the equation which links energy (*E*), power (*P*) and time (*t*).

(1)

(d) The hydroelectric generator transfers electrical power of 3000 W to the village.

Calculate the energy transferred to the village in 60 minutes.

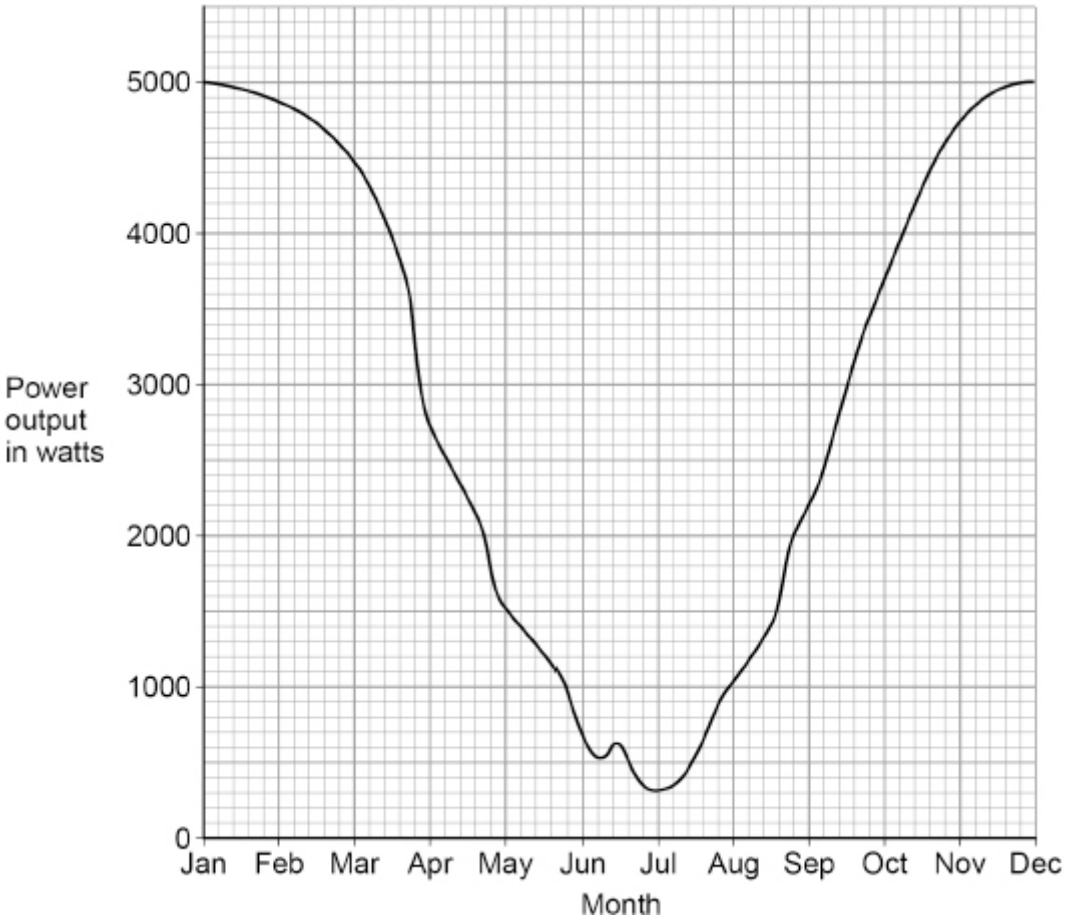
Energy transferred = _____ J

(3)

(e) The hydroelectric generator is turned by falling river water.

Figure 2 shows how the power output of the hydroelectric generator varied during one year.

Figure 2



Explain **one** reason why the power output varied.

_____

_____

_____

_____

_____

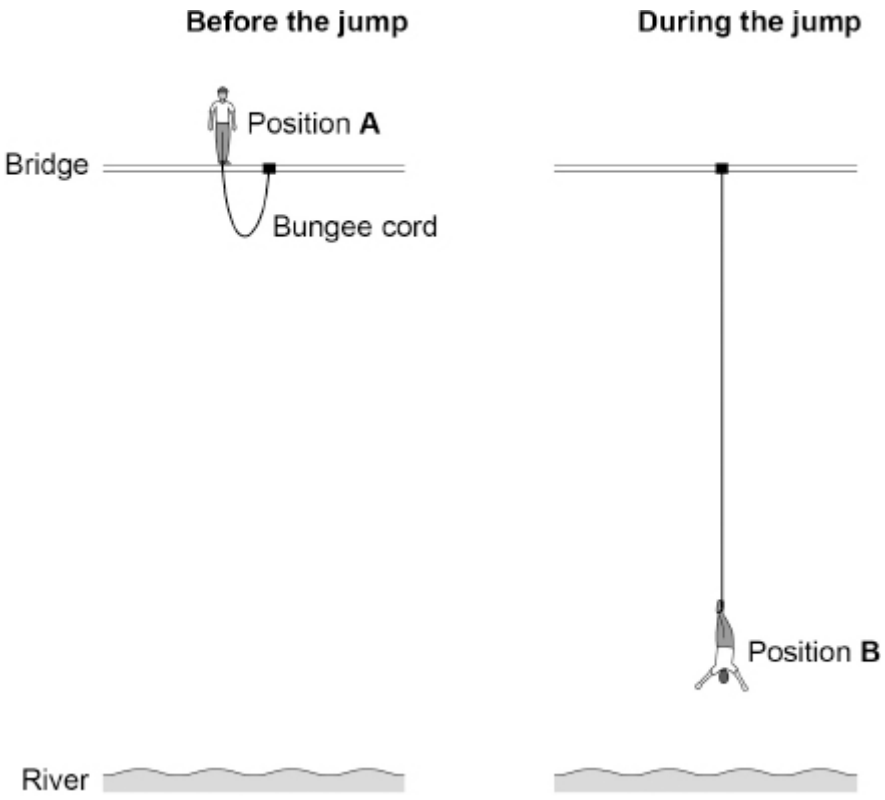
(2)

(Total 10 marks)

Q5.

The figure below shows a student before and during a bungee jump.

The diagram is not to scale.



(a) In position **B**, the student is moving towards the river and the bungee cord is stretching.

How do the energy stores in position **B** compare with the energy stores in position **A**?

Tick (✓) **one** box in **each** row.

Energy store	**Less than at A**	**The same as at A**	**More than at A**
The student's gravitational potential energy			
The student's kinetic energy			
The bungee cord's elastic potential energy			

(3)

(b) The bungee cord behaves like a spring with a spring constant of 78.4 N/m.

At one point in the bungee jump, the extension of the bungee cord is 25 m.

Calculate the elastic potential energy stored by the bungee cord.

Use the equation:

elastic potential energy = 0.5 × spring constant × extension^2

_____

_____

_____

Elastic potential energy = _____ J

(2)

The table below shows information about different bungee cords.

Bungee cord	Spring constant in N/m	Maximum extension before snapping in metres
A	78.4	36
B	82.0	24
C	84.5	12

(c) Bungee cord **C** will have a smaller extension than **A** or **B** for any bungee jumper.

Give the reason why.

_____

_____

(1)

(d) Which bungee cord would be safest to use for a person with a large weight?

Give a reason for your answer.

Bungee cord _____

Reason _____

_____

(2)

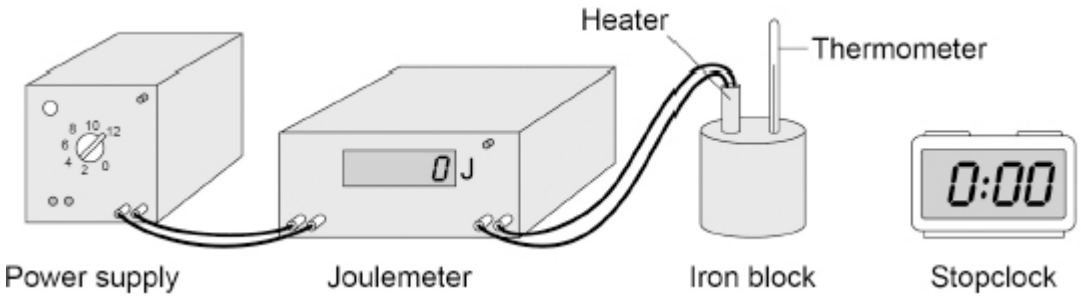
(Total 8 marks)

Q6.

Figure 1 shows the equipment a student used to determine the specific heat capacity of iron.

The iron block the student used has two holes, one for the heater and one for the thermometer.

Figure 1



(a) Before the power supply was switched on, the thermometer was used to measure the temperature of the iron block.

The student left the thermometer in the iron block for a few minutes before recording the initial temperature.

Suggest why.

_____

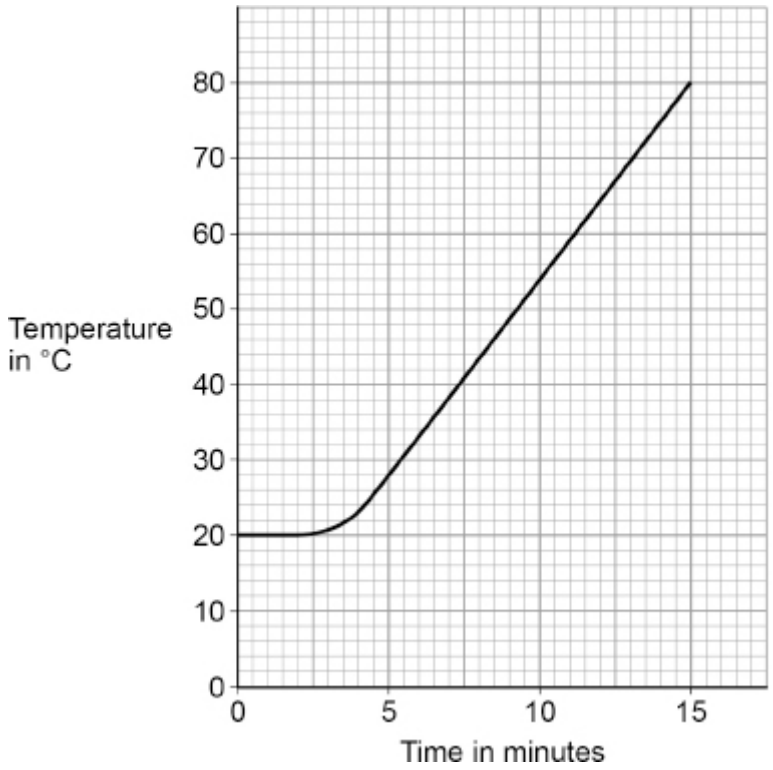
_____

_____

(1)

(b) **Figure 2** shows how the temperature changed after the power supply was switched on.

Figure 2



The energy transferred to the iron block between 5 and 10 minutes was 26 000 J.

The mass of the iron block was 2.0 kg.

Calculate the specific heat capacity of iron.

Use information from **Figure 2** and the Physics Equations Sheet.

Specific heat capacity = _____ J/kg °C

(4)

(c) The student repeated the investigation but wrapped insulation around the iron block.

What effect will adding insulation have had on the investigation?

Tick (✓) **two** boxes.

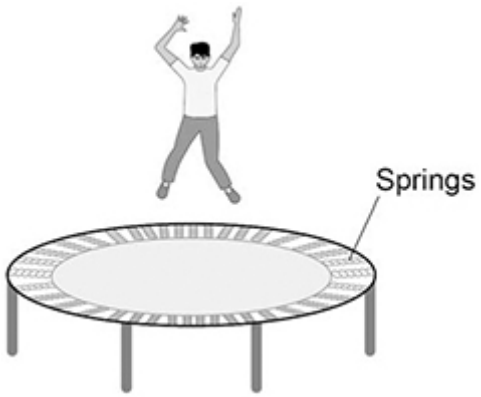
The calculated specific heat capacity will be more accurate.	☐
The iron block will transfer thermal energy to the surroundings at a lower rate.	☐
The power output of the heater will be lower than expected.	☐
The temperature of the iron block will increase more slowly than expected.	☐
The uncertainty in the temperature measurement will be greater.	☐

(2)

(Total 7 marks)

Q7.

The figure shows a boy bouncing on a trampoline.



(a) The boy falls from the position in the figure above towards the trampoline.

Complete the sentences.

Choose answers from the box.

chemical	**elastic potential**	**gravitational potential**
kinetic	**nuclear**	

As the boy falls, there is a decrease in his _____ energy.

As the boy falls, there is an increase in his _____ energy.

(2)

(b) As the boy lands on the trampoline, each spring stretches 0.015 m.

spring constant of each spring = 120 000 N/m

Calculate the energy stored by each spring.

Use the equation:

elastic potential energy = 0.5 × spring constant × (extension)^2

_____

_____

_____

Elastic potential energy = _____ J

(2)

(c) There are 40 springs on the trampoline.

Calculate the total energy stored by the 40 springs when each spring is stretched by 0.015 m.

Use your answer from part (b)

_____

_____

Total energy stored = _____ J

(1)

(d) The kinetic energy of the boy as he lands on the trampoline is 600 J.

The maximum kinetic energy of the boy after he bounces is 45% of his kinetic energy as he lands.

Calculate the maximum kinetic energy of the boy after he bounces.

_____

_____

_____

Maximum kinetic energy = _____ J

(2)

(e) Why is the kinetic energy of the boy after he bounces less than his kinetic energy as he lands?

Tick (✓) **one** box.

Energy is not conserved.	☐
Energy is transferred to the surroundings.	☐
The springs transfer energy to the boy.	☐

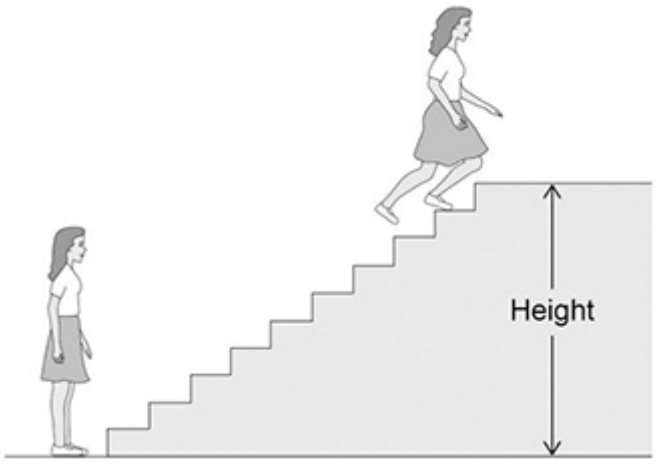
(1)

(Total 8 marks)

Q8.

A girl ran to the top of some stairs.

The figure shows the stairs.



(a) The girl measured the height of the stairs.

What measuring instrument should she have used?

_____

(1)

(b) The height of the stairs was 1.7 m.

The mass of the girl was 50 kg.

gravitational field strength = 9.8 N/kg

Calculate the change in gravitational potential energy of the girl.

Use the equation:

gravitational potential energy = mass × gravitational field strength × height

_____

_____

_____

_____

Gravitational potential energy = _____ J

(2)

(c) A boy ran up the same stairs and did 1800 J of work.

The time it took the boy to run up the stairs was 1.44 s.

Calculate the power of the boy.

Use the equation:

$$\text{power} = \frac{\text{work done}}{\text{time}}$$

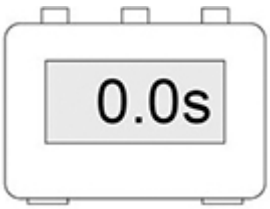
Power = _____ W

(2)

(d) Which stop-clock was used to measure the time the boy took to run up the stairs?

Tick (✓) **one** box.

Stop-clock A

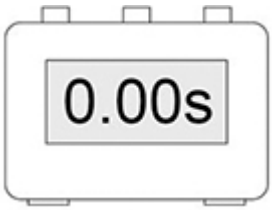


☐

Stop-clock B

☐

Stop-clock C



☐

(1)

(e) The boy had a speed of 2.0 m/s at the top of the stairs.

The mass of the boy was 70 kg.

Calculate the kinetic energy of the boy at the top of the stairs.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

_____

_____

_____

_____

Kinetic energy = _____ J

(2)

(Total 8 marks)

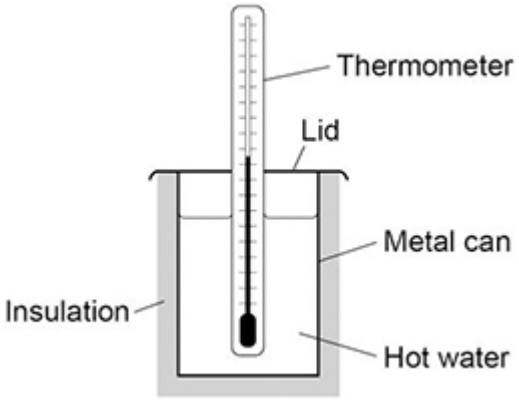
Q9.

A student investigated the insulating properties of two different materials.

The same thickness of each material was used.

Figure 1 shows some of the equipment used by the student.

Figure 1



The student used two different types of thermometer to measure the temperature changes.

Figure 2 shows a reading on each thermometer.

Figure 2

(a) What is the resolution of thermometer **B**?

Tick (✓) **one** box.

0.1 °C ☐

0.4 °C ☐

67.0 °C ☐

67.4 °C ☐

(1)

(b) Complete the sentence.

Choose the answer from the box.

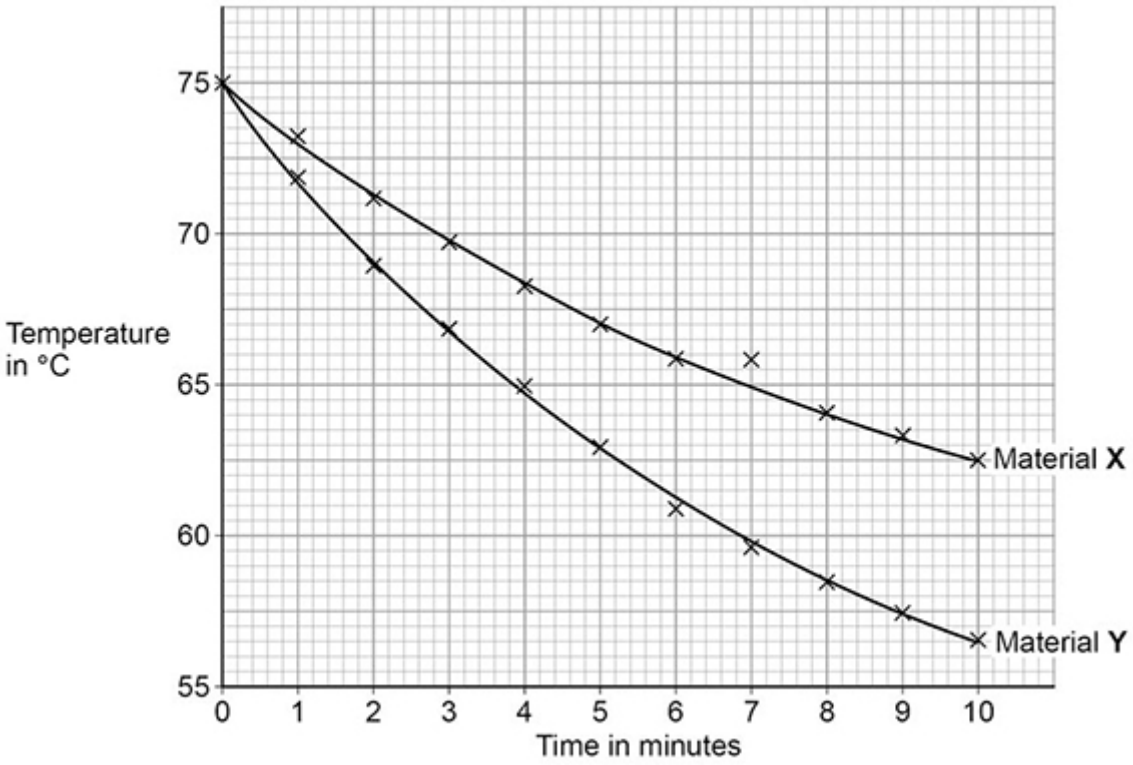
a smaller	the same	a bigger

Thermometer **A** has _____ chance of being misread than thermometer **B**.

(1)

Figure 3 shows the results.

Figure 3



(c) The mass of water used was 0.12 kg.

specific heat capacity of water = 4200 J/kg °C

Determine the total change in thermal energy of the water when Material **X** was used.

Use values from **Figure 3**.

Use the Physics Equations Sheet.

_____

_____

_____

_____

_____

_____

Total change in thermal energy = _____J

(4)

(d) There is an anomalous result on **Figure 3**.

Draw a ring around the anomalous result.

(1)

(e) Give **two** conclusions that can be made from **Figure 3**.

1. _____

_____

_____

2. _____

_____

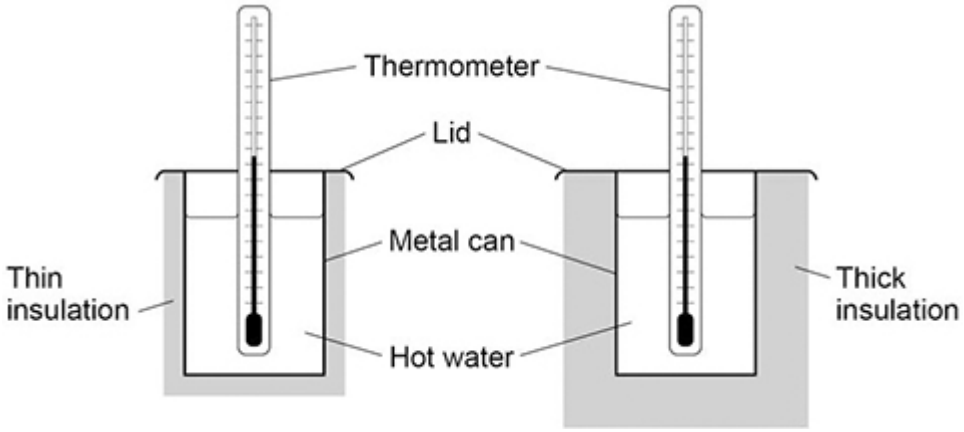
_____

(2)

Another student investigated how the thickness of the insulation affected the rate of cooling of hot water.

Figure 4 shows some of the equipment used.

Figure 4



(f) How would using thick insulation affect the rate of cooling of hot water compared with using thin insulation?

Tick (✓) **one** box.

The rate of cooling would be higher. ☐

The rate of cooling would be lower. ☐

The rate of cooling would not change. ☐

(1)

(g) Predict how using thick insulation would affect the temperature of the water after 10 minutes compared with using thin insulation.

Tick (✓) **one** box.

The temperature would be higher. ☐

The temperature would be lower. ☐

The temperature would be the same. ☐

(1)

(Total 11 marks)